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ABSTRACT

Educational changes may be required in order to realize the benefits that computer assisted learning (CAL) can offer geography instruction. CAL could make the learning and teaching of geography truly efficient and practically eliminate failures of instruction. An institutional constraint that discourages instructional innovations is the conflict between the demands on professors that are inherent in the research/publish model and the time and effort needed for significant improvements in instructional practice. CAL requires large amounts of time and effort for the development of effective programs. This time is not available to professors because of the time demands of the research/publish model. In addition, the research/publish model encourages the excessive intellectualization of all subjects. Significant improvements in university instruction in geography are likely to be produced only in the less intellectualized aspects of the subject, such as applied geography and environmental analysis. Institutions should permit professors to devote time and effort to instructional development without suffering penalties in career advancement and remuneration. (RM)

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A Model For Information-Based And Computer-Assisted Learning In Geography

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ABSTRACT

CAL, along with other compatible learning and teaching practices, could make learning and teaching of geography truly efficient and could practically eliminate failures of instruction. However, the potential great benefits of CAL may not be realized. Preceding innovations in university instruction have had few long term effects. Their limited impact on instructional practice may have been due mainly to institutional constraints that discourage instructional innovations, constraints that are as important today as they were earlier. Fundamental institutional changes may be required in order to realize a significant proportion of the benefits that CAL and other practices can offer in geography and similar academic subjects.

The underlying barrier to significant improvement in university instruction is the conflict between the demands on professors that are inherent in the research/publish model and the time, effort and other requirements for significant improvements in instructional practice. CAL requires large amounts of time and effort for development of effective programs, which is not available to professors because of the time demands of the research/publish model. In addition, the research/publish model encourages excessive intellectualization of all subjects and produces other impediments to development of efficient learning and teaching programs.

Significant improvements in university instruction in geography are likely to be produced only in the less intellectualized aspects of the subject, such as applied geography and environmental analysis. But development of significant amounts of effective CAL would require institutional changes to permit professors to devote time and effort to instructional development without suffering penalties in career advancement and remuneration. The changes required include replacement of the present research/publish model with a model that is compatible with the development of efficient learning and teaching programs.

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INTRODUCTION

The effects on university education, of programs using efficient learning and teaching methods could be dramatic. Learning and teaching could be made truly efficient; high levels of success and low levels of failure could be achieved. I believe that many programs of instruction now requiring four or five years to complete could be reduced to three years or less. For some environmental subjects, for example, the level of competence now typically requiring completion of a Master program could be achieved by undergraduate programs of instruction.

There have been many complaints about the effectiveness of university and other levels of education. Since 1945, many solutions to problems of university instruction have been proposed, have been instituted (often in a number of variants), and then have gradually faded from attention. Some were fundamentally unsound., but some may have provided real improvements in instruction, if used properly. Most of these innovations were significant departures from traditional lecture/textbook methods of instruction. Programmed learning, using teaching machines, along with a supporting psychological theory, had a vogue in the 1950's and 1960's. Other innovations received less attention: personalized system of instruction (PSI); independent learning; contract learning; resource-based learning; competency-based learning; contingency managed learning; guided design; audio-visual tutorial and other audio-visual learning; simulation and games playing; several variants of CAL; and others. Trials of the different methods have demonstrated that significant improvements in the efficiency of learning and teaching are possible. Most of these innovations are still being used on a small scale.

Computers have become so important in professional, business and government operations, and are such an important part of the North American economy, that CAL will receive increasing attention and use in universities. Computer technology is appealing not only to professors, but to boards of governors, to administrators and to other decision makers.

Most of the instructional innovations that have been introduced since 1945 have been used incorrectly, with the possible exception of audio-visual methods. There are many possibilities for using computer technology incorrectly in learning and teaching programs. This is occurring in many primary and secondary schools where computers have been introduced in the absence of good education programs, software or courseware.

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There are many institutional and other barriers to the effective use of CAL and its great potential benefits are not likely to be realized fully. CAL is more likely to be used incorrectly than correctly in university instruction; it is likely that many applications of CAL will be suboptimal.

CAL has the potential of being a large and expensive failure. The great expense of CAL, especially during the early stages of development, combined with some disappointing results, could lead to declines in interest, similar to those that occurred with preceding instructional innovations.

The introduction of computers into schools has followed a similar pattern at all levels. Large amounts of equipment have been introduced, and the many technical problems of getting the equipment to work properly have been addressed. Major efforts have been devoted to problems of hardware and to debugging and refining operating systems. Much less attention has been given to the development of programs for instruction or learning. As a result, lack of good educational software is the most serious limiting factor to effective use of computers and of CAL, at all levels of education. BYTE magazine (June 1984) reported a survey of recent computer instruction and research installations in major American universities. There was an evident emphasis on equipment and a comparatively small use of resources to develop software or courseware.

Some earlier innovations were accepted uncritically as quick and easy solutions to serious problems facing universities and were adopted without adequate identification of objectives, adequate consideration of alternatives, or adequate identification and analysis of likely consequences. The most important and most consistent error has been that university professors and administrators have believed that the solution lay in the technique. They have not appreciated that real improvements in learning and teaching requires far more than changes in teaching technique.

Successful solutions will require exhaustive analysis of the problems of university instruction, and identification of all of the available alternative ways of improving learning and teaching. Choosing among the available alternatives will require setting of detailed objectives, stated in terms of the specific information and skills to be learned. There appear to have been few examples of exhaustive problem analyses in recent attempts at instructional innovation in universities, and solutions seem to have been chosen even before the problem was defined. This seems to be happening on a large scale as many computer systems are installed without adequate knowledge of the functions they will be expected to perform.

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Computers And Design Of CAL

The instructional literature of computer applications contains many examples of inefficient and efficient learning and teaching practices. Many instructional manuals for computers and computer programs are models of inefficient learning and teaching practice. Often, they were written by people with advanced knowledge of the technology, but who seemed unaware of the problems faced by beginners in the use of computers; many such manuals require excessive time and effort to master. This has created a large market for 'user-friendly' instruction manuals. These manuals, often written by professional writers or teachers, facilitate learning of the necessary terminology and procedures and facilitate finding information needed to solve problems that may arise in use.

All examples of efficient instruction in the use of computers are based on detailed analysis of the information and skills that are required to produce a satisfactory level of competence or performance. The most effective instructional manuals for computer applications are outstanding examples of good expository writing style, combined with effective use of illustrations and exercises. The design of efficient learning and teaching materials for computer applications requires competent persons, with thorough knowledge of the subject, supplied with the time, materials, and other resources needed to produce superior learning and teaching materials.

It required more than one year for good applications programs to be produced for the IBM PC and the Apple Macintosh computers, even though the potential market was large and profitable. Although many of these programs are complex, the problems they address are comparatively simple, and are well understood. The more complex the subject, or the less clearly defined or ambiguous, the more difficult is the design of learning or teaching programs. Many academic subjects are complex and may be approached in many different ways. The instructional software that is needed for complex academic subjects will be difficult to develop. Much of it will probably have a comparatively small market, and may be unprofitable; it will require university or other resources for its development.

Many computer programs, developed for other purposes, are useful for course and program development. In addition to the necessary word processing and data base programs, programs for idea processing, project planning, and other tasks, would be useful for developing efficient learning and teaching programs. However, computer technology is not a critical limitation to the development of efficient learning and teaching practices; other limitations are more critical.

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CAL And Environmental Analysis

Computer assisted learning has been used mostly for two purposes. The most common use is to teach or develop computer competence. The other main use is in the learning or instruction of other subjects, such as physical geography.

It is comparatively easy to use computers to develop computer competence, because many available applications programs lend themselves to this purpose. Most of the uses of computers for learning and teaching in geography have been of this type, with emphasis on quantitative and statistical procedures that have been applied by geographers.

Design of CAL for geography and environmental analysis requires organization of the subject matter in ways that facilitate learning and use. It is much easier when there are good textbooks or compilations of research reports. One of the most promising subject areas for development of good CAL is applied geography and environmental analysis.

The requirements for more efficient learning have been demonstrated in the recent literature of environmental and resource analysis. This literature includes many bibliographies, collections of articles and reports about specific subjects, many kinds of databases, and arrangements for database access by means of computer terminals. In this literature, compilations of recent articles and reports have supplanted textbooks as superior sources for the current state of thought and practice. These compilations, sometimes proceedings of conferences, present contemporary reports on current information and procedures, usually representing the thought and work of many people. For instructional purposes, such compilations have many advantages over textbooks, especially for subjects in which the information and procedures used by competent problem solvers are changing rapidly. The problem faced by the developers of CAL programs is how to make these compilations of information available to people who are not already specialists in the specific subject matter.

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The problem for efficient learning is to gain access efficiently to the current literature and professional practices of competent environmental and resource analysts and to develop the skills needed to use this literature, as well as other information, to solve problems and make decision. The solution is to make the relevant literature and analytical practices easily available, and to facilitate learning the terminology, skills, and other requirements to permit an interested person to make independent and effective use of the relevant literature. This solution would require the provision of information of a type and amount that is much different from what is normally provided in geography programs. It would require development of competence in accessing databases, and other types of information, which is comparatively simple, but usually requires access to large amounts of information; this may involve use of computer equipment and programs.

Efficiency can be attained in the learning and teaching of specific subjects. But competence in geographic analysis, resource analysis and environmental analysis requires learning the equivalent of many courses, a program or a curriculum. Realization of most of the potential benefits would require substantial redesign of curricula, which is usually very difficult in universities.

CAL And The Research/Publish Model

The development of good CAL materials requires far more time and effort than the lecture/textbook/readings method of instruction commonly used in geography subjects. Computers can increase the efficiency of courseware development, but it will still require large investments of time, attention and effort. The development of complete courseware programs for a single course, for example, would probably be even more demanding than production of a substantial textbook, because of the great amount of detail required for all subjects covered.

Effective use of CAL can be achieved only if professors and other CAL developers devote the necessary large amounts of time and effort to this task. Effective introduction of CAL in geography, for example, would require massive commitments by individual professors, departments and universities for several years, and probably for much longer. However, such a massive redeployment of effort is not possible without significant changes in the rewards and sanctions used to control the ways professors use their time and other resources. The research/publish model is not compatible with large scale development of good CAL.

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I have seen no evidence that the massive redeployment of resources needed for successful CAL is widely recognized. University administrators seem to believe that the introduction of CAL on a significant scale will require only the provision of more computers and more complete computer systems. They seem to believe that professors will then devote more of their attention to the development of CAL, while continuing current practices of teaching and research. This misperception of CAL will not make effective use of the large new computer systems that are being installed. There likely will be more CAL, but most will be sub-optimal in quality, and there will not be enough of it.

The research/publish model requires the production of significant amounts of published material by most professors. This, in turn, requires the commitment of large amounts of time and effort to research, writing and meeting the demands of reviewers, editors and publishers. The lecture/textbook method of instruction is dominant in most university subjects mainly because it permits professors to devote the required amount of time and effort to research and publication.

CAL makes new demands on professors and other developers or programs. It requires great attention to detail and large amounts of continuous concentrated work. The time and effort required for production of good CAL is so great that time devoted to research and publication must be reduced. Professors will not be able to meet the publication quotas which are now such an important part of university administrative practice; they will either have to accept lower money rewards or seek changes in the way their work is evaluated.

The kind of mind set, and the kinds of work habits, required by CAL are quite different from the expectations that lead graduate students to choose academic careers. Aspiring academics usually are seeking a more leisured, less disciplined, more intellectual, lifestyle than seems to be required for production of good CAL.

Continuous production of good CAL will require recruitment of people who are more like computer programmers than traditional university professors. The kind of people needed may not be found in sufficient numbers in traditional academic departments. If large amounts of good CAL are to be produced, conditions suitable for its production must be established, designed to attract and hold the kinds of people who are capable of producing good CAL. New types of institutional environments may have to be developed to produce significant amounts of good CAL.

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Among the choices facing universities are: (1) continue to use the research/publish model without change; (2) retain the research/publish model but allow CAL development to be treated as equivalent to research and publication; (3) develop a new model which is completely compatible with effective use of CAL and other learning/teaching technologies.

I believe that only the latter alternative, which may be called the efficient learning model, will realize the potential great social benefits of efficient learning and teaching. However, I expect university administrators to resist changes in their accustomed practices of evaluating professors by the use of countable products, like publications. Therefore, it is likely that the present research/publish model will undergo slow changes as professors try to develop effective CAL programs within the severe constraints of that model.

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CONCLUSIONS

The technology of efficient education is now adequate to produce significant improvements in efficiency of teaching. The literature of efficient teaching and of applied resource and environmental analysis suggests that the design of efficient methods of learning and of teaching have essentially the same solution: the organization of information and skills in sequences that facilitate learning and the development of skills of application, combined with procedures that require the learner to actually carry out the required tasks (or alternatives that produce equivalent results). The requirements for producing desired levels of learning have been demonstrated, for a number of specific courses, by several instructional methods, including Personalized System of Instruction (PSI).

The greatest benefits from the development of efficient learning and teaching would accrue to society as a whole, in the saving of large amounts of money and time that are wasted by current inefficient practices of teaching and learning. Students would benefit from significant reductions in the time, effort, and expense required to reach given levels of skill, competence, or knowledge. Professors who are interested mainly in teaching, or who do not agree with the existing research emphasis of universities, would benefit by being able to reorient their professional activities to more congenial objectives.

However, many professors and others have interests and competences which are not compatible with significant development of CAL. Many professors would have to discard much of their present educational practice. Some would have to invest large amounts of time and effort to develop the materials required for efficient teaching programs, and to design sequences of instruction. Many administrators would be unhappy with teaching and learning practices which would require them to develop new ways of evaluating the work of professors.

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